

## CLAIMS

- 1 1. A device for performing electron-ion fragmentation reactions comprising:  
2 (a) a multi-electrode structure,  
3 (b) a generator delivering radiofrequency voltages to the multi-electrode structure  
4 to form an electric multipolar radiofrequency field,  
5 (c) an ion source delivering ions into the radiofrequency field, where the ions are  
6 confined in a spatially limited region by the radiofrequency field for at least some  
7 period of time,  
8 (d) a magnetic field source for superimposing a magnetic field on the electric  
9 radiofrequency field, and  
10 (e) an electron source for providing electrons with energies below approximately  
11 20 electronvolts into said spatially limited region.
- 1 2. Device according to Claim 1 wherein the multi-electrode structure consists of  
2 straight rods.
- 1 3. Device according to Claim 2 wherein the multi-electrode structure consists of four  
2 parallel straight rods.
- 1 4. Device according to Claim 1 wherein the multi-electrode structure consists of ring  
2 and end cap electrodes.
- 1 5. Device according to Claim 4 wherein the multi-electrode structure consists of one  
2 hyperbolically shaped ring and two hyperbolically shaped end cap electrodes.
- 1 6. Device according to Claim 1 wherein the ion source delivers multiply charged  
2 ions.
- 1 7. Device according to Claim 6 wherein the ion source is an electrospray ion source.

- 1 8. Device according to Claim 1 wherein the ion source comprises an ion selector for  
2 selecting ions with respect to their mass-to-charge ratio.
- 1 9. Device according to Claim 1 wherein an additional generator delivers AC or DC  
2 voltages to the multi-electrode structure to eject ions of preselected mass-to-  
3 charge ratios.
- 1 10. Device according to Claim 1 comprising a damping gas source to deliver a  
2 damping gas to the multi-electrode structure to damp the motion of the ions and  
3 to form a cloud of ions in the center of the multi-electrode structure.
- 1 11. Device according to Claim 1 wherein the electron source comprises an electron  
2 emitter.
- 1 12. Device according to Claim 11 wherein the electron emitter is located within the  
2 magnetic field in such a way that the electrons can reach locations near the  
3 center of the multi-electrode structure by following the magnetic field lines.
- 1 13. Device according to Claim 1 wherein the electron source comprises a voltage  
2 generator delivering an acceleration voltage for the electrons.
- 1 14. Device according to Claim 13 wherein the voltage generator comprises an  
2 electron pulser for pulsing the electrons whereby the time of pulses may be  
3 locked to the phase of the radiofrequency voltage.
- 1 15. Device according to Claim 1 wherein the electron source comprises a pulse laser  
2 for generating electrons in short pulses.
- 1 16. Device according to Claim 1 wherein the magnetic field is generated by one or  
2 more permanent magnets.

- 1 17. Device according to Claim 1 wherein the magnetic field is generated by electric  
2 current through one or more coils.
- 1 18. A method of obtaining efficient ion-electron reactions comprising the steps of:  
2 (a) providing a multipolar electric radiofrequency field for storage or guidance of  
3 ions,  
4 (b) providing positive or negative ions in a spatially limited region inside the  
5 radiofrequency field where the ions are confined at least some period of time;  
6 (c) providing electrons inside said region with kinetic energies of the electrons  
7 below approximately 20 eV, to allow ion-electron reactions; and  
8 (d) providing a magnetic field inside said region sufficiently strong to confine the  
9 motion of said electrons in the direction perpendicular to said magnetic field.
- 1 19. The method according to Claim 18 wherein a force field assists in directing and  
2 guiding the electrons produced outside the spatially limited region into said  
3 region.
- 1 20. The method according to Claim 18 wherein the electrons are provided within a  
2 small time window of a few nanoseconds, the time being locked to the phase of  
3 the radiofrequency voltage.